CLAIMS

What is claimed is:

1. A method comprising:

receiving a sensor signal comprising a raw sensor value from a sensor, the raw sensor value associated with a position of a manipulandum in a range of motion; and

outputting an output signal comprising an adjusted raw sensor value, the adjusted raw sensor value associated with a compliance between the sensor and the manipulandum.

2. A method as recited in claim 1, wherein the compliance is associated with a compliance constant and a current output force.

3. A method as recited in claim 1, further comprising determining a closed-loop position-dependent force based at least in part on the raw sensor value.

4. A method as recited in claim 1, wherein further comprising transmitting forces from an actuator to the manipulandum with a belt drive.

5. A method as recited in claim 1, further comprising filtering the raw sensor value for overshoot sensor values occurring at limits to the range of motion of the manipulandum.

6. A method as recited in claim 1, further comprising calibrating the range of motion of the manipulandum by adjusting minimum and maximum values of the range of motion based at least in part on the extent of motion of the manipulandum up to a designated time.

7. A method as recited in claim 1, further comprising normalizing the raw sensor value to a normalized range of motion, wherein the adjusted raw sensor value is further associated with the normalized raw sensor value.

8. A device comprising:

a manipulandum;

a linkage mechanism providing a degree of freedom to the manipulandum;

a sensor operable to sense a position of the manipulandum in the degree of freedom and to output a raw sensor value representing the position; and

a processor, operable to:

receive a sensor signal from the sensor, the sensor signal comprising the raw sensor value; and

output an output signal comprising an adjusted raw sensor value associated with a compliance between the sensor and the manipulandum.

9. A device as recited in claim 8, wherein the linkage mechanism includes a chain of four rotatably-coupled members coupled to ground at each end of the chain.

10. A device as recited in claim 8, further comprising an actuator coupled to the linkage mechanism, the actuator operative to output a force in the degree of freedom;

11. A device as recited in claim 9, further comprising a belt drive transmission coupled between the actuator and the linkage mechanism.

12. A device as recited in claim 8, wherein the sensor comprises a relative digital encoder.

13. A device as recited in claim 8, wherein the sensor is coupled to the actuator such that the sensor is operable to detect rotation of a shaft of the actuator.

14. A device as recited in claim 8, wherein the processor is operable to calibrate the range of motion of the manipulandum by adjusting minimum and maximum values of the range of motion based at least in part on the extent of motion of the manipulandum up to a designated time.

15. A device as recited in claim 8 wherein the processor is operable to determine a closed-loop force based at least in part on the raw sensor value.

16. A method comprising:

receiving a sensor signal comprising a raw sensor value from a sensor, the raw sensor value associated with a position of a manipulandum in a range of motion;

filtering the raw sensor value for overshoot sensor values occurring at limits to the range of motion of the manipulandum; and

calibrating the range of motion of the manipulandum by adjusting minimum and maximum values of the range of motion based at least in part on the extent of motion of the manipulandum up to a designated time, wherein the calibration is based at least in part on the filtered sensor value.

17. A method as recited in claim 16, further comprising determining a position of the manipulandum in the range of motion based at least in part on the raw sensor value.

18. A method as recited in claim 16, wherein the filtering includes using a low pass filter on the raw sensor value.

19. A method as recited in claim 16, wherein the calibrating includes assigning an initial range with initial maximum and initial minimum values to the manipulandum.

20. A method as recited in claim 19, further comprising asjusting the minimum and maximum values to maintain the initial range between the minimum and maximum values until both the minimum and maximum values are detected outside the initial range.

21. A method as recited in claim 19, wherein if the filtered sensor value is below the minimum value, further comprising:

setting the minimum value to the filtered sensor value, and

adjusting the maximum value to maintain a constant range from the minimum value, unless the maximum value has previously been detected outside the initial range.

22. A method as recited in clam 21, wherein if the filtered sensor value is above the maximum value, further comprising:

setting a maximum value to the filtered sensor value; and

adjusting the minimum value to maintain a constant range from the maximum value, unless the minimum value has previously been detected outside the initial range.

23. A method as recited in claim 16, further comprising adjusting the raw sensor value based at least in part on a compliance of the force feedback device.

24. A method as recited in claim 16 further comprising normalizing the raw sensor value.

25. A method as recited in claim 24 wherein the normalizing includes providing a saturation zone at each limit of the normalized range, the saturation zone causing a raw sensor value over a saturation level provided at the ends of the normalized range of motion to be adjusted to the saturation level.

26. A method comprising:

receiving a raw sensor value representing a position of a manipulandum in a range of motion of the manipulandum from a sensor; and

outputting an output signal comprising a normalized raw sensor value, wherein the normalized raw sensor value is based at least in part on a normalized range of motion.

27. A method as recited in claim 26 wherein the normalized raw sensor value is based at least in part on normalizing according to a normalizing function, the normalizing function being a linear function having the saturation levels at the ends of the linear function, wherein the normalizing function has a greater slope between the ends of the range of motion than a normalizing function without the saturation zones.

28. A method as recited in claim 26 further comprising adjusting the raw sensor value based at least in part on a compliance between the sensor and the manipulandum.

29. A method as recited in claim 26 determining a force based at least in part on the normalized range of motion.

30. A method as recited in claim 29 wherein the determination the forces comprises determining a closed-loop condition force,

31. A method as recited in claim 30, wherein the closed-loop condition force comprises one of a spring force, a damping force, and a texture force.

32. A method as recited in claim 26 further comprising calibrating the range of motion of the manipulandum by adjusting minimum and maximum values of the range of motion based at least in part on the extent of motion of the manipulandum up to a designated time.